

REMARKS

Drawings

The Examiner has stated that the informal drawings submitted are not sufficient quality to permit examination. The Examiner has request new drawings in reply to the above referenced Office Action. Submitted herewith are Formal Drawings in compliance with 37 C.F.R. 1.81. Applicant was given a two month time period to submit new drawings. Applicant submits herewith a Petition for a Extension of Time under 37 C.F.R. 1.136(a).

Claim Rejections - 35 U.S.C. § 102/103

Nogami

The Examiner has rejected claims 1-3 under 35 U.S.C. 102(e) as anticipated over Nogami et al., (US Patent 6,02,808). The Examiner has rejected claims 4-9 under 35 U.S.C. 103(a) as being unpatentable over Nogami et al., (US Patent No. 6,022,808).

It is Applicant's understanding that Nogami et al. fails to teach or render obvious Applicant's invention as claimed in amended claims 1-4 and 7-9. Applicant teaches and claims a method of forming a copper alloy comprising plating a layer of copper over a substrate, and then *"forming a dopant layer comprising aluminum or cobalt over the copper layer"*. Dopants are then driven from the dopant layer into the copper layer. Applicant understands Nogami to describe forming a doped copper layer 14 over an undoped copper layer. The doped copper layer contains a dopant element selected from the group consisting of palladium, zirconium, tin, magnesium, chromium and tantalum.

Nogami fails to teach a dopant layer comprising aluminum or cobalt as claimed by Applicant. As such, Nogami fails to teach or render obvious Applicant's invention as claimed in claims 1-4 and 7-9. Applicant therefore respectfully requests the removal of the 35 U.S.C. 102 and 103 rejections of claims 1-4 and 7-9 and seeks an early allowance of these claims.

Andricacos

The Examiner has rejected claims 10-16 under 35 U.S.C. 102(e) as anticipated over Andricacos et al., (US Patent 6,268,291). The Examiner has rejected claims 17-18 under 35 U.S.C. 103(a) as being unpatentable over Andricacos et al., (US Patent 6,268,291).

It is Applicant's understanding the cited references fail to teach or render obvious Applicant's invention as claimed in claims 10-18. In claims 10-18 Applicant claims a method of forming a copper alloy layer comprising plating a layer of copper over a substrate and then implanting a least one dopant element selected from the group consisting of aluminum, magnesium and tin into the plated copper layer. Applicant understands Andricacos to teach a method of forming a copper conductor where non-metallic impurities selected from the group consisting of carbon (c), oxygen (o), chlorine (Cl), sulfur (s) and nitrogen are implanted into a main copper conductor 90/100. The non-metallic impurities are implanted into the as plated copper conductor. In an embodiment of Andricacos, a dual implantation process is used wherein a second implantation step is used for a secondary surface modification step. (Col. 12, lines 58-67) In this step, metal ions selected from copper, aluminum, tin, indium, titanium and chromium are implanted into the copper layer previously implanted with the non-metallic ions. As such, Andricacos describes implanting aluminum, tin, indium,

titanium and chromium ions into a previously implanted copper layer and not into the plated layer as claimed by Applicant.

Additionally, with respect to claim 13-15, Applicant claims forming a barrier layer over the interconnect lines prior to or after implanting the interconnect lines. Contrary to the Examiner's statement, barrier layer 94 of Andricacos is not formed over copper interconnect 90/100. (See Figure 4B and Figure 5B)

For the above mentioned reasons, it is Applicant's understanding that Andricacos fails to teach or render obvious Applicant's invention as claimed in claims 10 and 12-18. Applicant therefore respectfully requests the removal of the 35 U.S.C. 102 and 103 rejections of claims 10 and 12-18 and seeks an early allowance of these claims.

Havemann in view of Chiang

The Examiner has rejected claim 19 under 35 U.S.C. 102(e) as anticipated over Havemann et al., (US Patent 6,130,156). The Examiner has rejected claims 20-29 under 35 U.S.C. 103(a) as being unpatentable over Havemann et al., (US Patent 6,130,156) in view of Chiang et al., (US Patent 6,160,315).

Regarding claim 19, it is the Examiner's position that Havemann in Figure 2c and related text discloses a method of forming a copper interconnect comprising the step of depositing a seed layer 29 on a substrate, the seed layer 29 comprising copper and at least one doping element. (Col. 5, lines 37-42 and Figure 2c); forming a capping layer 31 over the seed layer 29 (Col. 5, lines 42-43 and Figure 2c); forming a copper layer 33 over the capping layer 31 (Col. 5, lines 44-45 and Figure 2c); and driving at least one dopant element from the seed layer 29 into copper layer 33 (Col. 5, lines 45-60 and Figure 2c).

It is Applicant's understanding the Havemann either alone or in combination with Chiang fails to teach or render obvious Applicant's invention as claimed in claims 19-29. In claims 19-29, Applicant claims a method of forming a copper alloy. According

to Applicant's claimed method, a seed layer 604 is deposited on the substrate wherein the seed layer 604 comprises copper and at least one dopant element. A capping layer 606 then formed over the seed layer. A bulk copper layer 604 is then formed over the capping layer 606. Dopants are then driven from the seed layer into the bulk copper layer.

It is Applicant's understanding that Havemann teaches to first form a doped layer 29. Next, a second layer 31 is formed. The second layer 31 is a copper seed layer. Havemann then forms a third layer which is the bulk copper layer 33. Havemann does not teach a seed layer wherein "*the seed layer comprises Cu and at least one dopant element*". In Havemann, the dopants reside in layer 29 and not in seed layer 31. Additionally, Havemann does not teach "*forming a capping layer over the seed layer*". In Havemann, the seed layer 31 is covered by bulk conductor 33 and not by a capping layer as claimed by Applicant.

As such, for the above mentioned reasons, it is Applicant's understanding that the cited references fail to individually or collectively Applicant's invention as claimed in claims 19-29. Applicant therefore respectfully requests the removal of the 35 U.S.C. 102 and 103 rejections of claims 19-29 and seeks an early allowance of these claims.

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

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Date: 4/18/02

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS

1. (Amended) A method of forming a Cu alloy, comprising:
plating a layer of Cu over a substrate;
forming a dopant layer **comprising Al or Co** over the Cu layer;
driving dopants from the dopant layer into the Cu layer; and
removing the dopant layer.

10. (Amended) A method of forming a Cu alloy, comprising:
plating a layer of Cu over a substrate; and
implanting at least one dopant element **selected from the group consisting of Al, Mg and Sn** into the **plated** Cu layer.